A Semi-supervised Nighttime Dehazing Baseline with Spatial-Frequency Aware and Realistic Brightness Constraint

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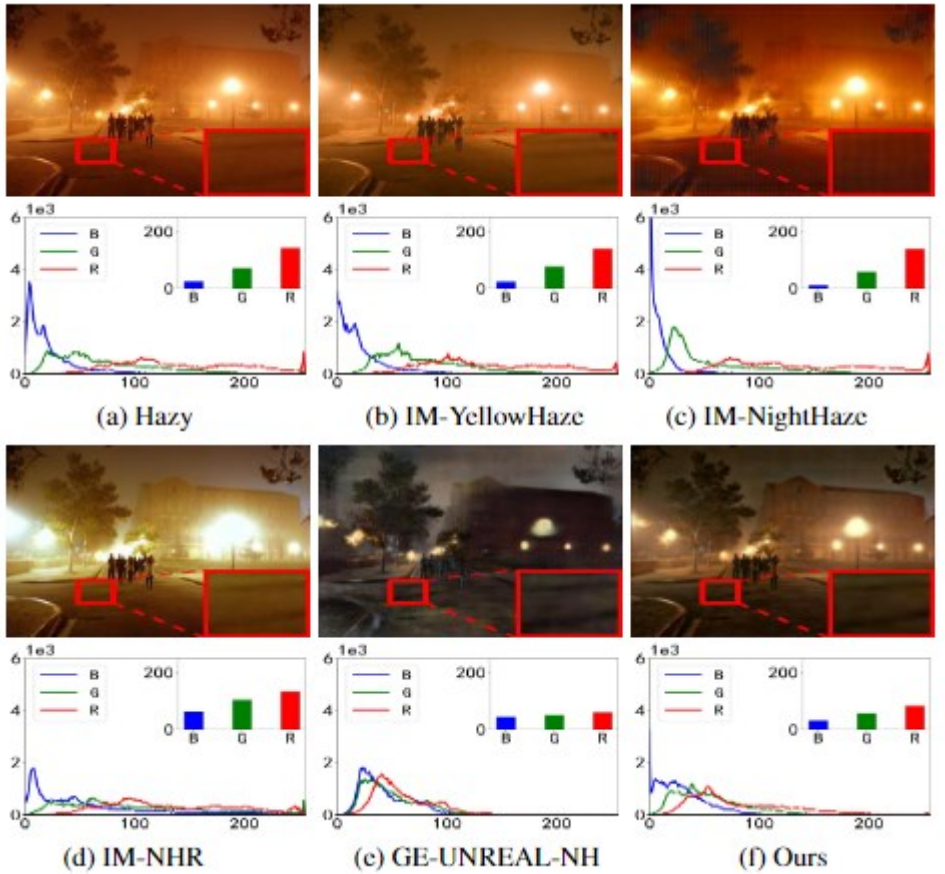
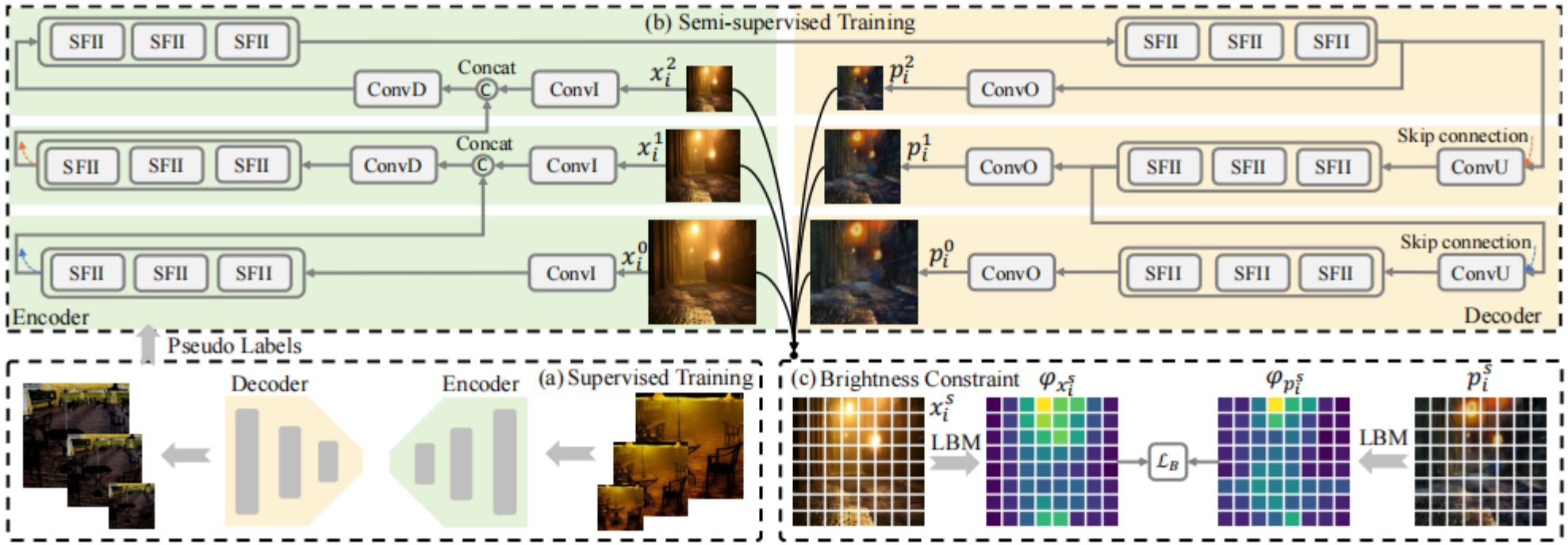
01 Motivation



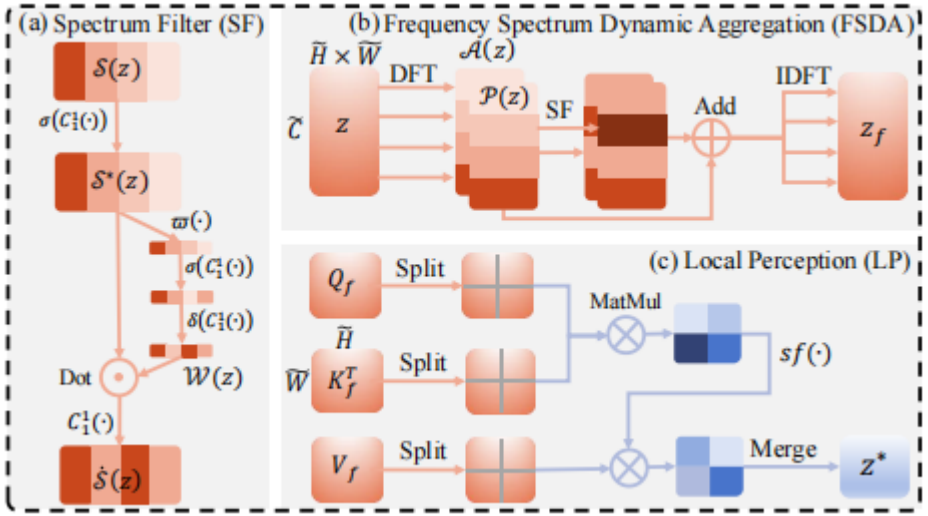
Visualization of real-world dehazed images, where the “IM-” and “GE-” denote the dehazed results obtained by training on imaging model (IM) and game engine (GE) simulated datasets, respectively.

02 Methods

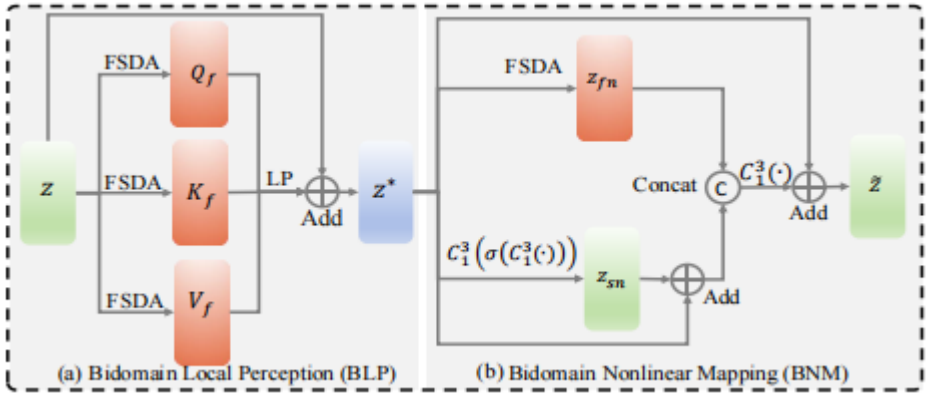


The overall pipeline of the proposed SFSNiD.

02 Methods

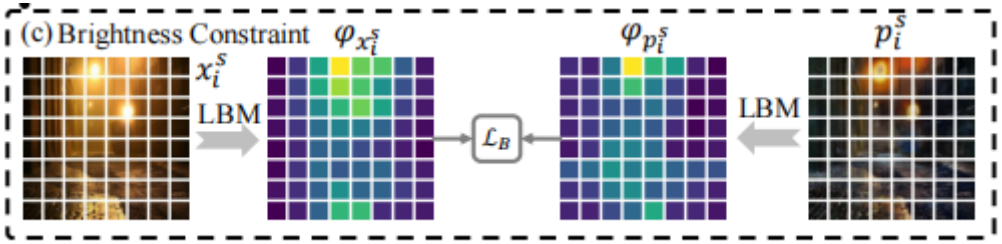


The sub-modules of the proposed SFII.



The overall architecture of the proposed SFII.

02 Methods



$$\varphi_{x_i^s}(\hat{h},\hat{w}) = \frac{1}{3(\gamma^s)^2}\sum_{c=0}^{2}\sum_{h=\hat{h}\cdot\gamma^s}^{(\hat{h}+1)\cdot\gamma^s}\sum_{w=\hat{w}\cdot\gamma^s}^{(\hat{w}+1)\cdot\gamma^s} x_i^s(h,w,c),$$

$$\widetilde{\varphi}_{x_i^s}(\hat{h},\hat{w}) = (\varphi_{x_i^s}(\hat{h},\hat{w}))^{\kappa},$$

$$\mathcal{L}_B^{p_i^s}(\hat{h},\hat{w}) = (\varphi_{p_i^s}(\hat{h},\hat{w}) - \xi\cdot\widetilde{\varphi}_{x_i^s}(\hat{h},\hat{w}))^2,$$

$$\mathcal{L}_B = \sum_{s=0}^{2}\frac{\lambda_b}{\hat{N}\hat{W}^s\hat{H}^s}\cdot\sum_{i=0}^{\hat{N}-1}\sum_{\hat{h}=0}^{\hat{H}^s-1}\sum_{\hat{w}=0}^{\hat{W}^s-1}\mathcal{L}_B^{p_i^s}(\hat{h},\hat{w}),$$

03 Results

Quantitative results on datasets that generated by imaging model.

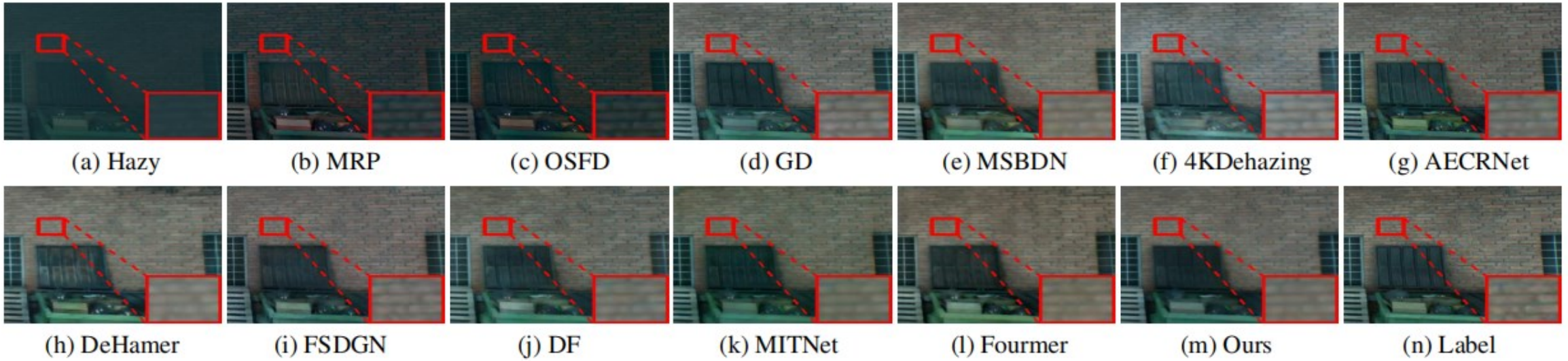
Methods	NHR		NHM		NHCL		NHCM		NHCD		NightHaze		YellowHaze	
	SSIM↑	PSNR↑	SSIM↑	PSNR↑	SSIM↑	PSNR↑	SSIM↑	PSNR↑	SSIM↑	PSNR↑	SSIM↑	PSNR↑	SSIM↑	PSNR↑
MRP (CVPR 2017)	0.776	19.848	0.666	15.993	0.747	22.497	0.693	20.494	0.624	17.651	0.295	12.138	0.249	13.473
GD (ICCV 2019)	0.969	30.107	0.861	20.689	0.973	36.506	0.958	34.448	0.932	31.509	0.832	25.324	0.915	27.410
OSFD (ACMMM 2020)	0.808	21.028	0.722	18.491	0.786	22.329	0.739	20.929	0.672	18.501	0.304	13.387	0.259	14.775
MSBDN (CVPR2020)	0.970	31.335	0.818	20.514	0.965	35.963	0.938	32.848	0.903	30.475	0.950	33.156	0.921	29.834
4KDehazing (CVPR2021)	0.950	28.613	0.830	20.429	0.967	35.006	0.958	35.162	0.912	30.048	0.850	26.562	0.861	25.835
AECRNet (CVPR 2021)	0.915	24.864	0.817	19.420	0.951	33.183	0.943	33.498	0.890	28.742	0.946	32.344	0.937	29.417
DeHamer (CVPR 2022)	0.966	31.017	0.823	23.095	0.966	36.038	0.944	33.908	0.915	31.389	0.954	33.432	0.931	30.334
FSDGN (ECCV 2022)	0.975	32.072	0.874	21.415	0.972	36.432	0.952	33.723	0.922	31.559	0.948	33.521	0.955	**33.062**
DF (TIP 2023)	0.969	31.644	0.896	23.207	0.975	37.383	0.960	35.038	0.934	32.079	0.931	31.489	0.948	32.244
MITNet (ACMMM 2023)	0.974	31.969	0.859	20.884	0.969	35.794	0.945	32.849	0.916	30.628	0.946	34.114	0.932	31.186
Fourmer (ICML 2023)	0.969	31.660	0.862	21.423	0.963	35.714	0.943	33.201	0.928	32.103	0.949	33.419	0.958	31.978
Ours	**0.978**	**33.180**	**0.905**	**23.705**	**0.979**	**38.146**	**0.968**	**36.146**	**0.951**	**34.001**	**0.968**	**35.527**	**0.965**	32.981

03 Results

Quantitative results on datasets generated by game engine (GTA5 and UNREAL-NH) and the real-world dataset (RWNH).

Methods	GTA5		UNREAL-NH		RWNH	
	SSIM↑	PSNR↑	SSIM↑	PSNR↑	BRISQUE ↓	MUSIQ ↑
MRP	0.662	19.460	0.467	10.039	**19.418**	41.194
GD	0.900	30.090	0.767	21.202	31.359	33.433
OSFD	0.711	21.461	0.443	9.169	20.860	**41.779**
MSBDN	0.909	32.029	0.827	25.680	38.910	29.968
4KDehazing	0.903	30.314	0.774	23.087	34.965	33.536
AECRNet	0.888	26.846	0.731	21.566	27.084	37.034
DeHamer	0.928	32.597	0.740	22.441	42.269	26.788
FSDGN	0.923	32.642	0.702	21.736	32.216	35.200
DF	0.918	32.856	0.770	23.017	33.678	31.663
MITNet	0.899	31.118	0.766	21.860	35.404	31.768
Fourmer	0.917	31.926	0.772	22.799	35.850	31.367
Ours	**0.935**	**33.708**	**0.862**	**25.907**	30.975	32.120

03 Results

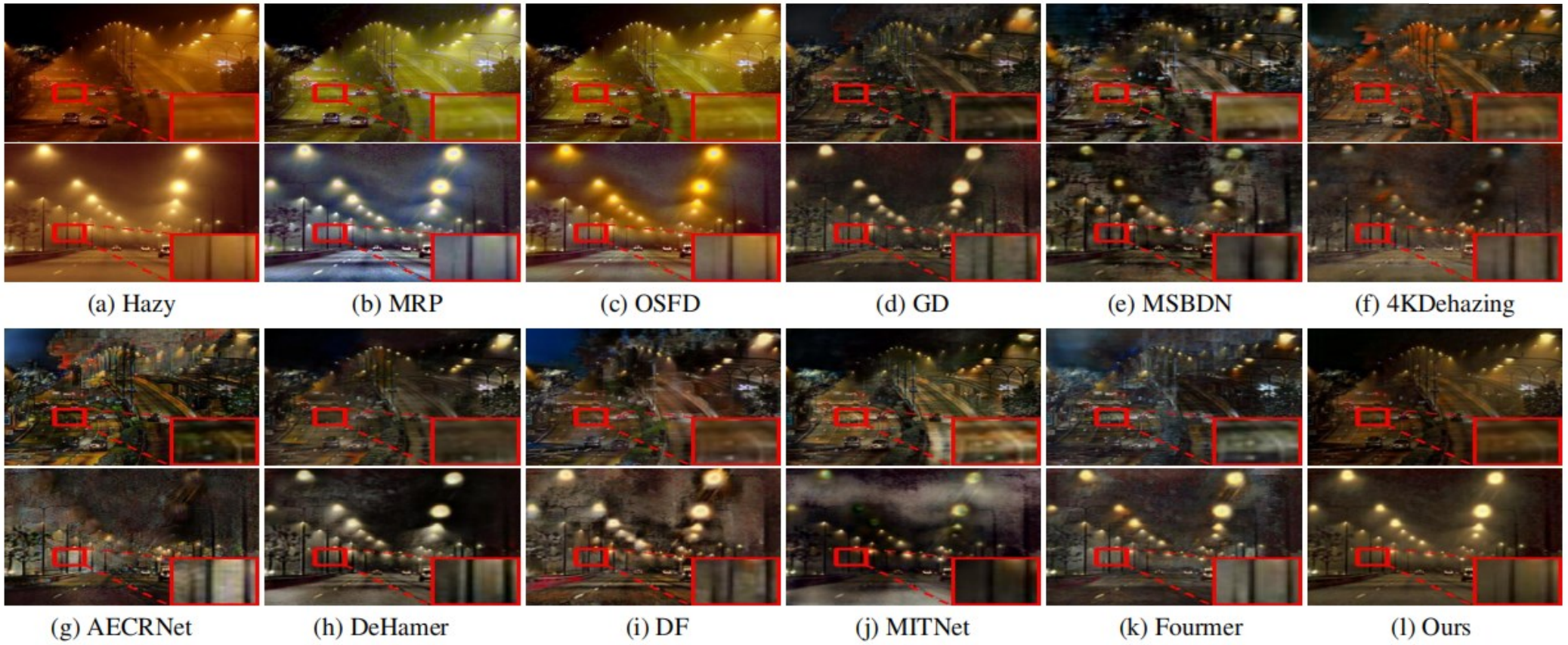


(a) Hazy (b) MRP (c) OSFD (d) GD (e) MSBDN (f) 4KDehazing (g) AECRNet

(h) DeHamer (i) FSDGN (j) DF (k) MITNet (l) Fourmer (m) Ours (n) Label

Visual results on synthetic dataset

03 Results



Visual results on real-world hazy images

03 Results

(a) Hazy (b) $\kappa = 1.0$ (c) $\kappa = 1.3$ (d) $\kappa = 1.5$ (e) $\kappa = 1.8$ (f) $\kappa = 2.0$ (g) $\kappa = 2.3$ (h) $\kappa = 2.5$ (i) $\kappa = 2.8$ (j) $\kappa = 3.0$

Dehazed images obtained under different κ

THANK YOU

Have a good day!